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ON THE MORPHOLOGY OF THE LARVAE OF THREE SPECIES OF CECIDOMYIDAE (DIPTERA) FROM KNAPWEED (*CENTAUREA*) FLOWERS

By G. W. Otter, M.A.

(*From the Molteno Institute for Research in Biology and Parasitology, University of Cambridge.*)

Communicated by Dr. A. D. Imms.

[Read 2nd February, 1938.]

With Sixty-Five Text-figures.

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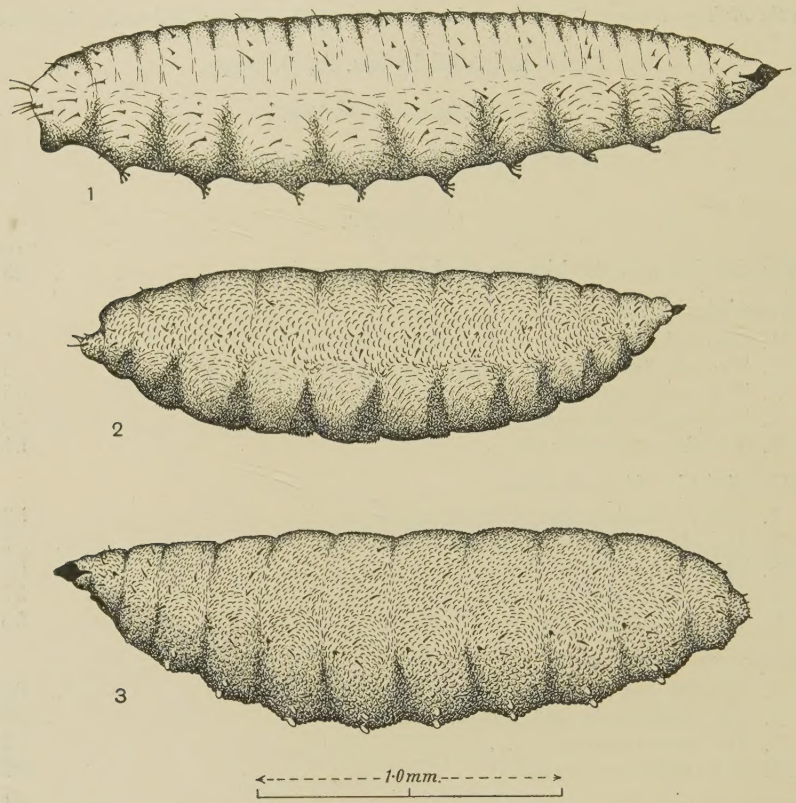
Introduction.

If the dead and dry flowers of Knapweed (*Centaurea nigra*) are collected in the winter, and the flowers pulled to pieces, among the many species of Diptera and other insect larvae that are found, are sure to be some small orange maggots. These are the larvae of the Cecidomyid, *Clinodiplosis cilicrus* Kieffer (fig. 2), a plant-feeding species. Among these larvae usually occur a few bright red larvae of another Cecidomyid, *Lestodiplosis miki* Barnes (fig. 1). These are of about the same size as those of *C. cilicrus*, and, like other members of this genus, are carnivorous. The larvae of *L. miki* are always far less numerous than those of *C. cilicrus*, and of 663 larvae collected in Surrey in December 1934, 607 were *C.*

cilicrus, while 56 were *L. miki*, an approximate proportion of 1 : 12. The larvae of *C. cilicrus* hibernate in the dead flower-heads and pupate in the spring. In the summertime a third species of Cecidomyid larva is found very commonly in these flowers. This is the larva of *Dasyneura miki* Kieffer (fig. 3), another plant-feeding species. This larva is whitish pink and slightly larger than the other two species. Mr. G. C. Varley of the Entomological Department at Cambridge, in a paper shortly to be published on the ecology of insects in Knapweed flowers, gives further figures regarding the relative abundance of the



FIGS. 1–3.—Lateral view of the adult larvae of:—1. *Lestodiplosis miki*; 2. *Clinodiplosis cilicrus*; 3. *Dasyneura miki*.

larvae of these three species of Cecidomyids. The larvae of *L. miki* feed on those of *C. cilicrus* and *D. miki*, in the same way as the larvae of *Lestodiplosis alvei* feed on the mites which infest bee-hives (Otter, 1934), and the larvae of other species of this genus on various mites, Psyllids and Coccids (Barnes, 1930 and 1933), but Mr. Varley states that they will also feed on many of the other insect larvae infecting the flowers. Mites occurring in the flower-heads did not, however, appear to be attacked. First instar larvae of *L. miki* and *C. cilicrus* were obtained, and are described after the adult larvae in each case. A description is given of the tracheal system of the adult larva of *L. miki* and *C. cilicrus*, while that of *Dasyneura* is described by Metcalf (1933) for *D. leguminicola*. Dr. Barnes states that the specimens of *Lestodiplosis* submitted to

him for identification consist of two distinct sets of specimens, both of which are very similar, but differ slightly from the type of *L. miki*. He considers that these may be either two distinct species, or two strains of *L. miki* which would be impossible to separate from each other or from the type except by extensive biological tests. However, considering the similarity of the larvae of such distinct species as *L. alvei* and the species of *Lestodiplosis* concerned here, these have been considered as *L. miki* in this present paper for the purpose of studying the morphology of the larvae.

On account of the small size of the head capsules of these minute larvae, the drawings of their anterior ends showing their complex detail and the relative position and proportions of the mouth parts, etc., must not be considered too accurate. In order to examine the head capsules in detail, the only satisfactory technique was to mount them in Faure's gum-arabic mounting medium, and then to crush them gently under a cover glass and hope that the various parts would float apart more or less undamaged. The high magnifications necessary, the refractive nature of the skeleton, together with the thickness of the head capsule, tend to mask the details of sutures and lines of demarcation between one structure and another. Perhaps in time to come, with better technique and optical equipment, and above all a greater knowledge of the comparative morphology of the larvae of Orthorrhaphous Diptera, some of these drawings and descriptions will be proved inaccurate and open to other interpretations.

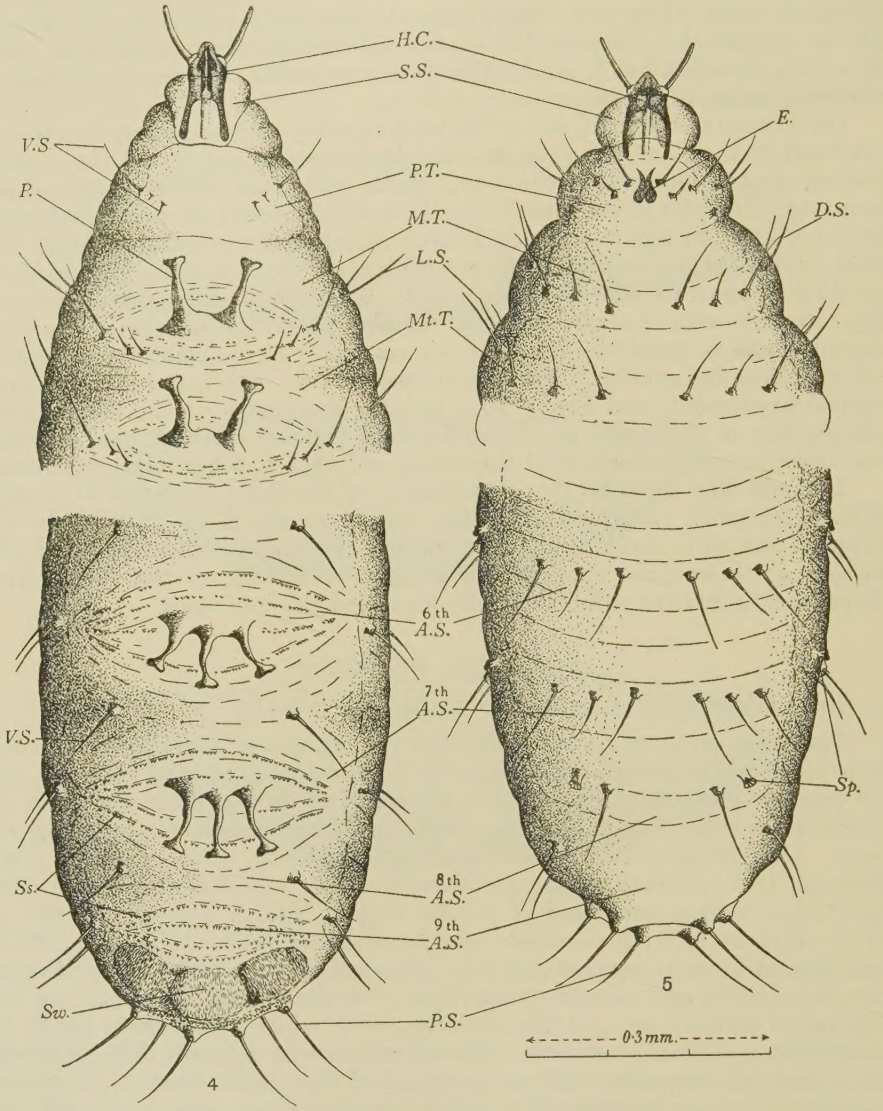
I would like to take this opportunity of thanking Professor D. Keilin, F.R.S., for much valuable help during this work, Mr. G. C. Varley, who has supplied me with material and information concerning the biology and life-history of these three species, and Dr. H. F. Barnes, of the Rothamsted Experimental Station, who has kindly identified the specimens.

Lestodiplosis miki Barnes.

1. *General description of the adult larva* (figs. 1 and 4–7).

The adult larva of *Lestodiplosis miki* (fig. 1) is very like that of *L. alvei*. It is blood red in colour, approximately the same size, 2·5 mm. in length and 0·6 mm. in greatest width, and, as is typical of all the other larvae so far described in this group of Diptera, consists of thirteen segments excluding the head. (*See* Busgen, 1895; Chaine, 1913; Hamilton, 1925; Kieffer, 1900; Marchal, 1897; Metcalf, 1933; Rubsaamen, 1899; and Williams, 1910.) The body (figs. 4–5) is composed of a head capsule (H.C.), a supernumerary or extra segment (S.S.) pro-, meso- and meta-thorax (P.T., M.T., and Mt.T.), and nine abdominal segments (A.S.). The dermal structures consist of setae, pseudopods (P.) and minute spines (Sp.). On the ventral surface of the last abdominal segment are pad-like swellings (Sw.), which can perhaps hardly be considered as dermal structures. The supernumerary segment (S.S.) is devoid of all dermal structures, and, as is typical of this genus, there is no sternal spatula. A single eye-spot (E.), which consists of two crescent-shaped pigmented regions fused on their convex sides along the mid-dorsal line, occurs on the anterior region of the body in either the prothorax or supernumerary segment, depending on the longitudinal movements of the larva. The opaque white fat body is easily seen through the transparent skin, and consists of two lateral and one ventral lobe in each segment. In many specimens these lobes are confluent, particularly the respective lateral ones in each segment. The anus (fig. 6 A.) is very inconspicuous, possibly due to the absence of dermal papillae so common in many of the other genera, papillae which by their presence show

up any irregularities in the skin. In position it is most unusual, being situated dorsally on the anterior region of the last abdominal segment, almost at its point of juncture with the eighth. It consists of a short longitudinal slit



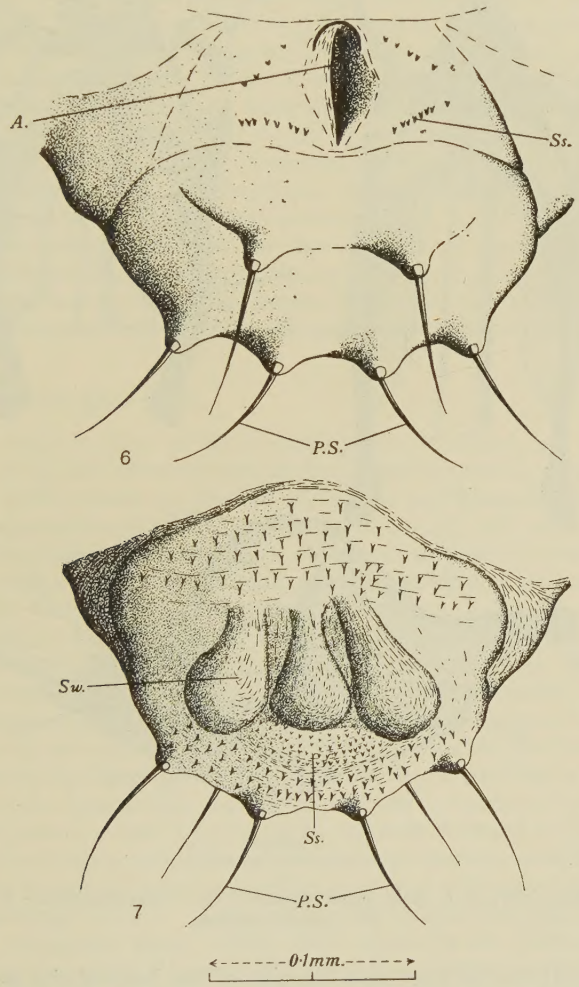
FIGS. 4–5.—Adult larva of *L. miki* first four and last four segments :—4. Ventral surface; 5. Dorsal surface.

along the mid-dorsal line, and is bordered anteriorly by a crescent-shaped sclerite; on either side is one, and sometimes two, short irregular transverse rows of spines (Ss.), this being the only position where these are found on the dorsal surface. In the case of *L. alvei*, the anus was described in error as being triangular in shape and situated anterior to the ventral protuberances on the last abdominal segment, a more normal position when compared with the

larvae of other genera. However, on re-examination of the little material available, the true anus was found to be in exactly the same position as in the above species, but is even more inconspicuous. The false position at first obtained was owing to a shallow pocket in the skin, which appeared conspicuous in some of the specimens treated with potash, while the true anus, just a crease on the dorsal surface, was overlooked.

2. *The chaetotaxy and dermal structures* (figs. 1 and 4–7).

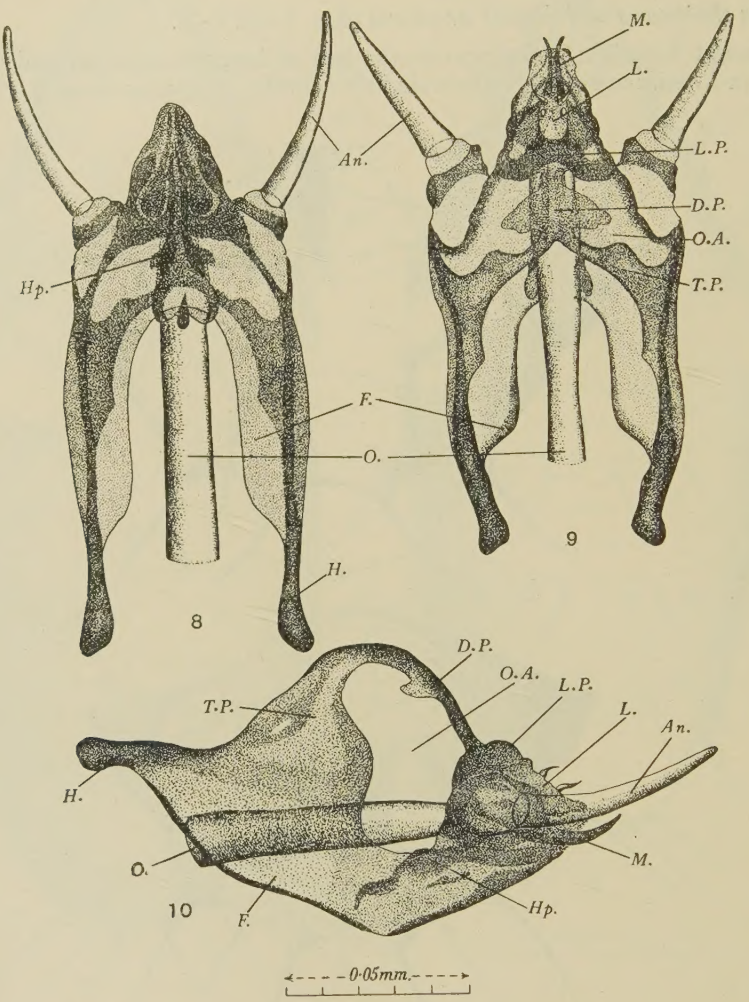
Except for slight differences in the last abdominal segment, and that the setae in *L. miki* are on the whole slightly shorter, averaging about 0·09 mm. in



FIGS. 6–7.—Adult larva of *L. miki*, last abdominal segment :—6. Dorsal surface; 7. Ventral surface.

length, the chaetotaxy and dermal structures are practically identical with *L. alvei*, and may be briefly described as follows.

Dorsally (fig. 5) on the meso- and meta-thorax, and the first seven abdominal segments, there is a transverse row of six setae (D.S.), a median pair and two lateral pairs, the inner lateral pair being shorter than the other two. Laterally there are two pairs of setae situated one above the other (L.S.), the setae of the upper pair being situated just below the spiracles (Sp.) in the case of the first seven abdominal segments. Ventrally (fig. 4) there is a pair of setae (V.S.)



FIGS. 8–10.—Adult larva of *L. miki*, head capsule :—8. Ventral surface; 9. Dorsal surface; 10. Lateral surface.

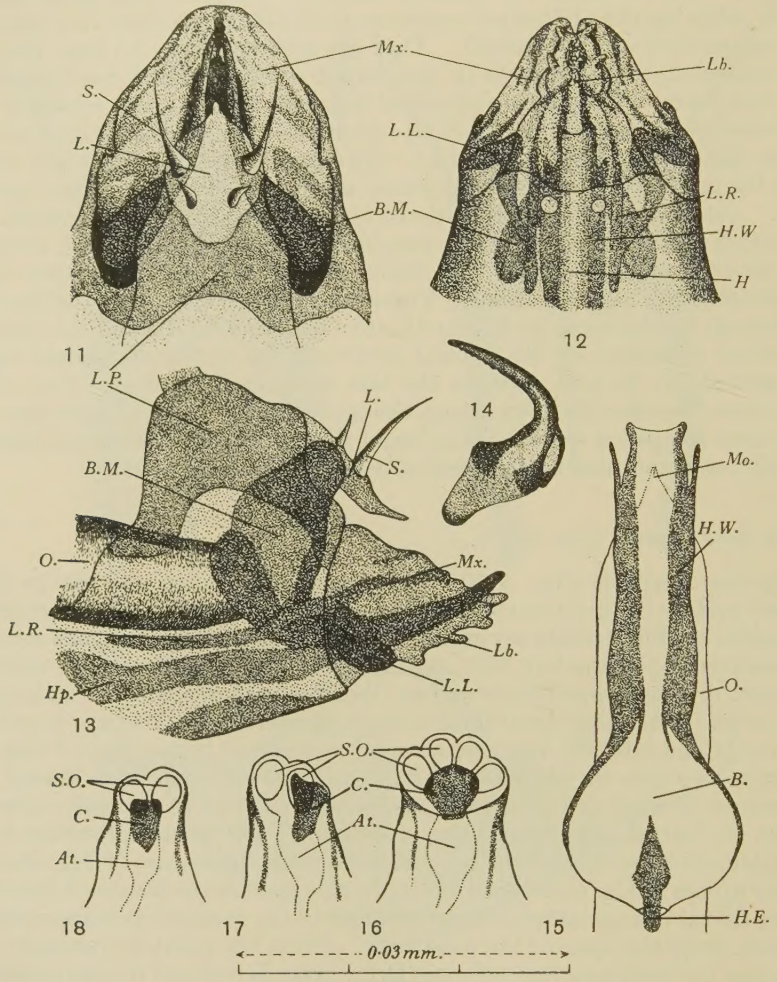
situated laterally on the posterior margins of the base of the pseudopods (P.). In the meso- and meta-thoracic segments this ventral pair of setae is accompanied by two very minute inner pairs. The chaetotaxy of the prothorax (P.T.) is similar to the meso- and meta-thorax (M.T. and Mt.T.), except that dorsally the inner lateral pair of setae are set more posteriorly than the others. The eighth abdominal segment bears the usual pair of lateral setae, only one

median dorsal pair of setae, which are set slightly posterior and inside the last pair of spiracles, and no ventral setae. The ninth abdominal segment (figs. 6 and 7) bears posteriorly a ventral row of four setae (P.S.), a median and a lateral pair, and above these a median pair; all are set on pronounced papillae. The pseudopods (P.) are lightly sclerotised fleshy protuberances arising from ventral swellings on the meso- and meta-thorax and the first seven abdominal segments. On the meso- and meta-thorax (M.T. and Mt.T.) the pseudopods are paired, while on the abdominal segments (A.S.) there are three in a transverse row, one median and two lateral. They are approximately 0·1 mm. long when fully extended, and terminate in fan-shaped swellings which are fringed with very fine hairs. The ninth abdominal segment (fig. 7) bears ventrally three transverse pad-like swellings (Sw.), two lateral and one median, and on its dorsal surface (fig. 6) the slit-like anus (A.). The anus is inconspicuous and situated along the mid-dorsal line a short distance anterior to the dorsal pair of posterior setae. Anteriorly the anus is bordered by a narrow semicircular sclerite. The only other dermal structures are irregular and frequently broken transverse rows of very minute spines (Ss.), which appear as minute serrations on the cuticle under low magnifications. Transverse rows occur around the base of the pseudopods on the meso- and meta-thorax (M.T. and Mt.T.) and the first seven abdominal segments, on the ventral surface of the eighth abdominal segment and around the ventral pads on the last abdominal segment. Two distinct rows occur between these pads and the more ventral pairs of posterior setae. They vary somewhat in size, being larger on the last two abdominal segments. Dorsally, as mentioned before, they only occur round the anus.

3. *The head capsule* (figs. 8–15).

The head capsule (figs. 8–10) is very similar in shape and size to that of *L. alvei*, and, as in this latter species, is comparatively small, some regions being impossible to differentiate accurately under the high magnifications necessary. It measures approximately 0·14 mm. in total length, 0·07 mm. in width and 0·08 mm. in height, and consists of an ill-defined sclerotised cone with its apex anterior and with many local thickenings and apertures. Its base is prolonged posteriorly and laterally into two strongly sclerotised horns (H.) 0·3 mm. long. Ventrally two thin fin-like skeletal flanges (F.) arise from these lateral horns and extend forward and downward, eventually meeting in the mid-ventral line to form the lateral and ventral sides of the cone. On the dorsal surface of each lateral horn two strongly sclerotised triangular projections arise (T.P.), which join at their apices in the mid-dorsal line. In this species the points of juncture of the two dorsal triangular projections and that of the ventral fins is approximately 0·06 mm. from the apex of the head cone. From the point of juncture of the triangular projections a thin sclerite (D.P.) extends forward to join anteriorly a thickly sclerotised region called for convenience the labrum-bearing-plate (L.P.). This thin plate forms the dorsal side of the cone, and is bounded laterally by two large oval openings (O.A.). Anterior to the labrum-bearing-plate (L.P.) is an obscurely triangular plate, which may represent the labrum (L., fig. 11) and which bears two pairs of lateral setae (S.), the anterior pair being the longer, the posterior very short. Ventrally the anterior floor of the head cone consists of an obscure area of local thickenings. Above this and lying ventral, and anteriorly in close proximity to the oesophagus, is a peculiar structure whose position corresponds to the hypopharynx (Hp. and fig. 15). It consists of two laterally placed rods (H.W.) lying almost parallel to one another, and posteriorly

it terminates in a bulb-shaped swelling (B.), which may possibly be a salivary reservoir. The bulb-shaped swelling (B.) has a thickened, posterior end (H.E.) which in lateral view appears to project ventrally. The oesophagus (O.) is a thickly sclerotised tube which extends back on an average for 0·11 mm. from the apex of the head cone. The presumed mandibles (M., fig. 14) are laterally placed and hook-like as in *L. alvei*, and are toothed along their concave



FIGS. 11–15.—Adult larva of *L. miki*, head capsule:—11. Anterior end, dorsal surface; 12. Anterior end, ventral surface; 13. Anterior end, lateral surface; 14. Mandible; 15. Hypopharynx; 16–18.—Spiracles, lateral view:—16. Last abdominal spiracle; 17–18. Prothoracic or abdominal spiracles.

margins. They have wide triangular bases (B.M.) which appear to articulate with the underside of the labrum-bearing-plate (L.P.). The mandibles are set at an angle to one another in the head capsule, their bases wide apart, but their convex sides touching each other medially. They are protrusible dorsally at the apex of the head-cone, and on account of their sickle-like shape their points spread out laterally the more their convex sides come into contact with

each other. Living prey is thus pierced by their points, and held firmly against escape or detachment by their divergence. The antennae (An.) are borne on lateral outgrowths from the anterior sides of the head capsule; they consist of two segments, a very short basal one consisting of a sclerotised ring, and a much longer terminal one approximately 0·05 mm. long.

Under a high magnification, a little more detail than that mentioned can be seen in the anterior region of the head capsule. Dorsally (fig. 11) lateral outgrowths from the posterior region of the thick labrum-bearing-plate (L.P.) bend down ventrally and extend forwards to form the lateral sides of the apex of the head-cone. The bases of the mandibles (B.M.) appear to be left exposed between these forward-extending lateral outgrowths and the labrum (L.). Below the presumed mandibles little detail can be differentiated, except the blurred outline of two lateral structures (Mx.) which appear in more detail when viewed ventrally. Ventrally (fig. 12) the floor of the head capsule terminates anteriorly about 0·015 mm. from its apex. The floor consists of a thinly sclerotised area formed, as stated before, by the fusion of the ventral fins. Just posterior to its termination are two laterally placed transparent circular areas or apertures on either side of the mid-ventral line. These may be sense-pits. Anteriorly there is situated an extremely thin plate (Lb.), roughly triangular in shape, which bears at its apex two pairs of minute laterally placed papillae. This plate, which is possibly a labrum, appears to join the base of the head capsule, but its boundary is very difficult to see. Immediately below lie the two rods (H.W.) of the presumed hypopharynx, their ends projecting a short distance beyond the anterior termination of the head capsule. On critical examination (fig. 15) the anterior ends of these rods (H.W.) appear to be joined by a semicircular line of demarcation, which gives the impression that the whole forms a closed tube with very thick lateral margins (the rods), or half a tube open dorsally along part or the whole of its length. The closing of the anterior ends of these hypopharyngeal rods was not noticed in *L. alvei*, and it is indeed very inconspicuous in this species. Below the anterior end of the hypopharynx (fig. 15) the oesophagus can be seen to terminate in a point with the mouth (Mo.) presumably at its apex. In lateral view (fig. 13) only a very obscure and approximate view can be obtained, on account of the masking of detail by the lateral outgrowths which bear the antennae and the antennae themselves, yet nevertheless some idea of the relative positions of the various mouth-parts can be obtained. The lateral extensions from the labrum-bearing plate (L.P.) can be seen to extend downwards, its posterior borders forming the anterior edges of the large oval openings (O.A.) in the middle of the head capsule, while anteriorly it can be seen to extend forward and eventually downwards, between which and the labrum (L.) the base of the mandible (B.M.) can be seen projecting. Ventrally this thickened area merges into the thin skeleton which forms the sides and floor of the head capsule. Underneath the sides of the head capsule (figs. 12, 13) can be seen the blurred outlines of two thick inverted L-shaped sclerites (L.L.), the posterior ends of which seem to run backwards to join two short rods (L.R.) which lie alongside and parallel to the thickened walls (H.W.) of the hypopharynx. It is difficult to see if these are in any way connected with the thick bases (B.M.) of the so-called mandibles which lie directly underneath. The anterior ends of these rods (L.R.) appear to run into the lateral structures (Mx.), as apparently also do the anterior ends of the L-shaped pieces (L.L.). These lateral structures (Mx.), which extend to the anterior extremity of the head capsule when viewed from below, appear remarkably like a pair of laterally placed appendages of an extremely delicate

and little-sclerotised nature, and may represent the maxillae. Their exact outline is very obscure, and their point of articulation with the head capsule, if appendages, was impossible to define.

From the arrangement and disposition of the mouth-parts it is very tempting to draw the following arbitrary conclusions as to how they are utilised when feeding on living prey. The prey is pierced and held in position by the diverging points of the presumed mandibles (M.) as described before. The lateral structures (Mx.), if they are appendages, possibly open laterally and hold the outside of the prey, the labrum (L.) is lifted, while the hypopharynx (Hp.) and the end of the oesophagus (O.) are thrust into the wound between the bases of the mandibles (B.M.). Saliva is injected into the prey down the hypopharyngeal tube (H.W.) from the reservoir (B.), which possibly may also act as a kind of pump. The saliva kills the prey and digests its contents. After a while the thickened ends of the oesophagus around the mouth (Mo.) expand, and the liquefied contents of the prey are sucked into the digestive tract down the thickly sclerotised oesophagus (O.), which from its structure should withstand considerable negative pressure.

4. *The respiratory system* (figs. 17, 18 and 20).

The respiratory system of the adult larva is peripneustic, with a pair of spiracles (figs. 4, 5, and 20) on every segment except the supernumerary (S.S.), meso- and meta-thoracic (M.T. and Mt.T.) and the last abdominal or anal segment, making nine pairs in all. The prothoracic and eighth abdominal pair of spiracles are situated more dorsally on their respective segments than those of the first seven abdominal segments, which are placed laterally. The prothoracic and first seven abdominal spiracles (figs. 17 and 18) are extremely small, about 0·007 mm. in diameter, and project approximately 0·015 mm. above the surface of the segments. They have two oval openings (S.O.) to the exterior, averaging about 0·003 mm. in diameter, which are arranged on two sides of a thickly sclerotised triangular region which is evidently the cicatrix or stigmatic scar (C.). The eighth abdominal spiracle (fig. 16) is slightly larger in diameter, about 0·009 mm., and has four apertures (S.O.) to the exterior, which are grouped in the same way around two sides of a roughly triangular cicatrix (C.). The spiracular openings (S.O.) lead into a well-defined flask-shaped atrium (At.), from which the trachea can be seen to emerge at the lower end. In common with the spiracles of other Dipterous larvae, there is no closing mechanism, nor can any form of filtering apparatus, such as fine hairs extending across the atrium or spiracular openings, be distinguished.

The tracheal system (fig. 20) consists of a pair of dorsal (D.T.) and a pair of ventral (V.T.) trunks, connected by lateral transverse branches (L.T.), into which short tubes run from the spiracles (Sp.). The dorsal trunks are joined together in every segment except the supernumerary, meso- and meta-thorax, and the ninth abdominal segments, by means of a dorsal transverse tracheal (D.T.T.) across the posterior region of each segment, in the centre of which is a distinct ampulla (Am.). The dorsal trunks (D.T.) are not straight, but curve inwards at the point of origin of the transverse branch (D.T.T.), which joins them, and outwards, at about the centre of each segment, from where run the lateral branches (L.T.) connecting the spiracles and the dorsal and ventral systems. The dorsal system (D.T.) gives off no conspicuous branches except in the prothorax and eighth abdominal segment. In the eighth abdominal segment a branch (D.V.) arises on the outer side of the short tube leading to the

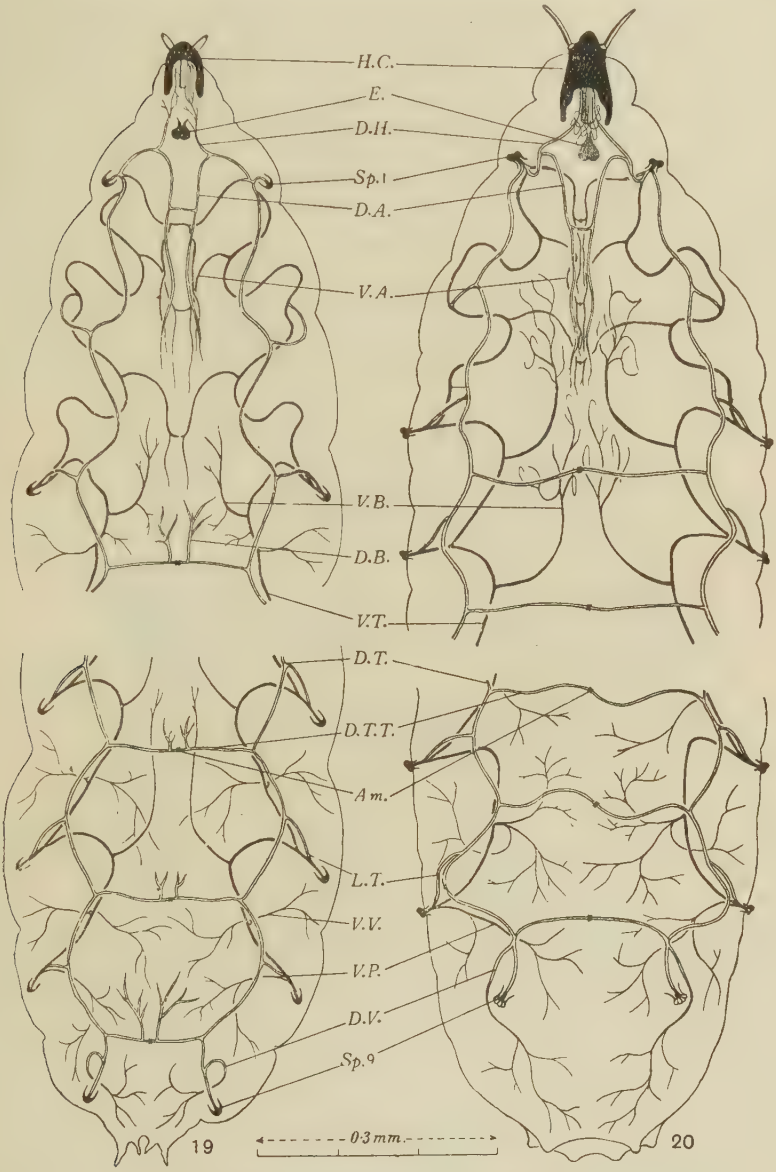
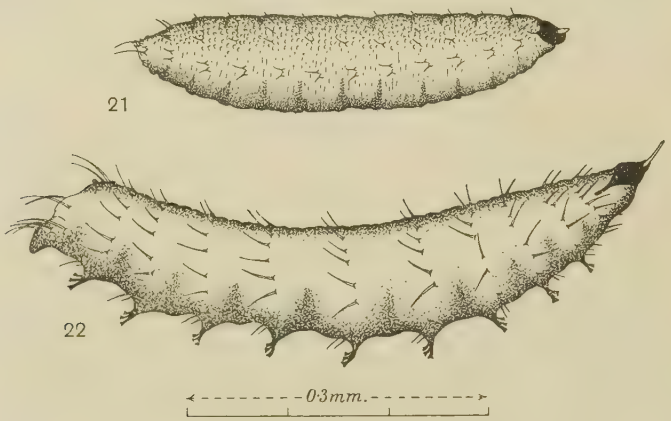


Fig. 19.—Adult larva of *C. cilicrus.*
Tracheal system, dorsal surface, the first five and the last five segments.

Fig. 20.—Adult larva of *L. miki.*
Tracheal system, dorsal surface, the first six and the last six segments.
[Double lines = the dorsal tracheal system]
[Solid lines = the ventral tracheal system]

dorsally situated spiracles on the ninth abdominal segment (Sp. 9), and runs posteriorly downwards, ramifying on the ventral surface of the ninth abdominal segment. The ventral trunks (V.T.) commence at the prothoracic spiracles

(Sp. 1) and extend posteriorly to the seventh abdominal segment. In their typical form, as in the abdominal segments, they consist of a series of roughly U-shaped tubes joined together end to end, with their convex sides extending ventrally, the apex of each loop lying approximately between the segments, the junction of the ends of every U-shaped loop forming the lower part of each lateral transverse branch (L.T.). From about the centre of each loop a large branch (V.B.) is given off which ramifies over the ventral surface, but in the first and second abdominal segments this branch curves anteriorly into the meta-thorax and first abdominal segment respectively before ramifying. In the seventh abdominal segment there is a posteriorly directed branch (V.P.) which ramifies over the ventral surface of the eighth abdominal segment. It arises at the point of the trunk's juncture with the last lateral transverse branch. The tracheal system in the thorax is somewhat different from the above. In the meso- and meta-thorax the dorsal trunks (D.T.) appear straighter than in the



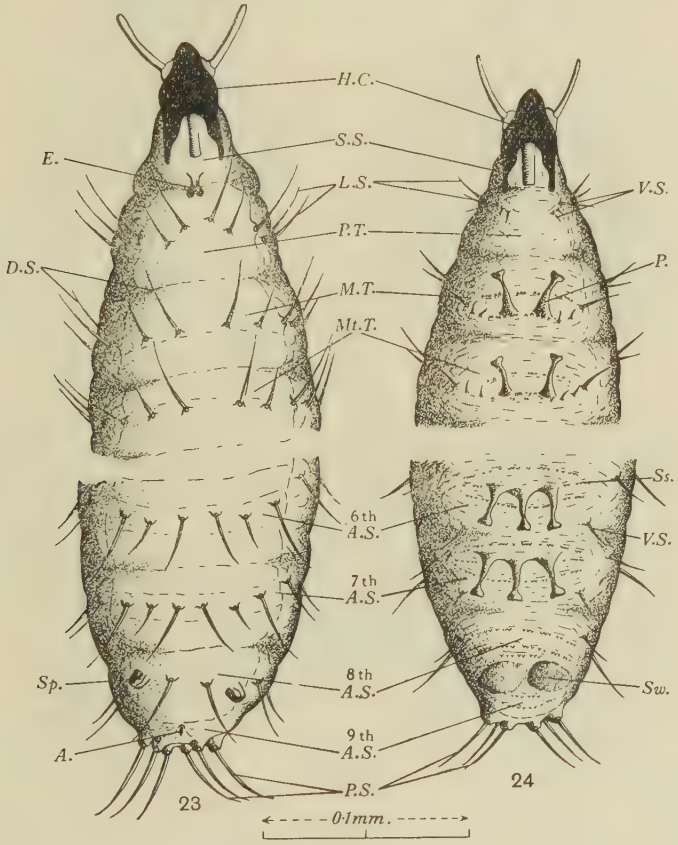
Figs. 21–22.—21. First instar larva of *C. cilicrus* just hatched from the egg; 22. First instar larva of *L. miki* fully grown.

abdominal segments, and there are no transverse joining branches, and only one lateral transverse branch (L.T.) to join the ventral system in the metathorax. The ventral trunks (V.T.), however, describe if anything closer and deeper loops, with an inner loop in both the meso- and meta-thorax, and an outer loop between these two. From the apices of these inner loops, in the normal position at which the abdominal branches (V.B.) would arise, a branch (V.A.) extends posteriorly along the ventral surface of the alimentary canal, and joins the corresponding one from the other side by means of a short tube, in the centre of which is an ampulla (Am.). Posteriorly these branches continue and ramify after their point of juncture. The ventral system joins the dorsal trunks at the prothoracic spiracles, and almost at their point of juncture in the prothorax two branches are given off. One of these runs downwards and backwards ventrally to join its corresponding branch from the other side, exactly as those (V.A.) in the meso- and meta-thorax, and is clearly a part of the ventral system. The other branch extends forward dorsally, and after a short distance divides into two. The more posterior of these branches (D.A.) runs backwards along the dorsal surface of the alimentary canal, and joins its corresponding branch from the other side in exactly the same way as in the posteriorly directed ventral branches (V.A.), but in this case there appears to be no ampulla on the short

tube which joins them. The other (D.H.) runs dorsally through the supernumerary segment and ramifies in and around the head capsule (H.C.) and oesophagus.

5. *The first instar larva* (figs. 22–33).

Having been able to obtain more specimens of the first instar larva of this species, a more detailed examination was made than was possible in the case of *L. alvei*.

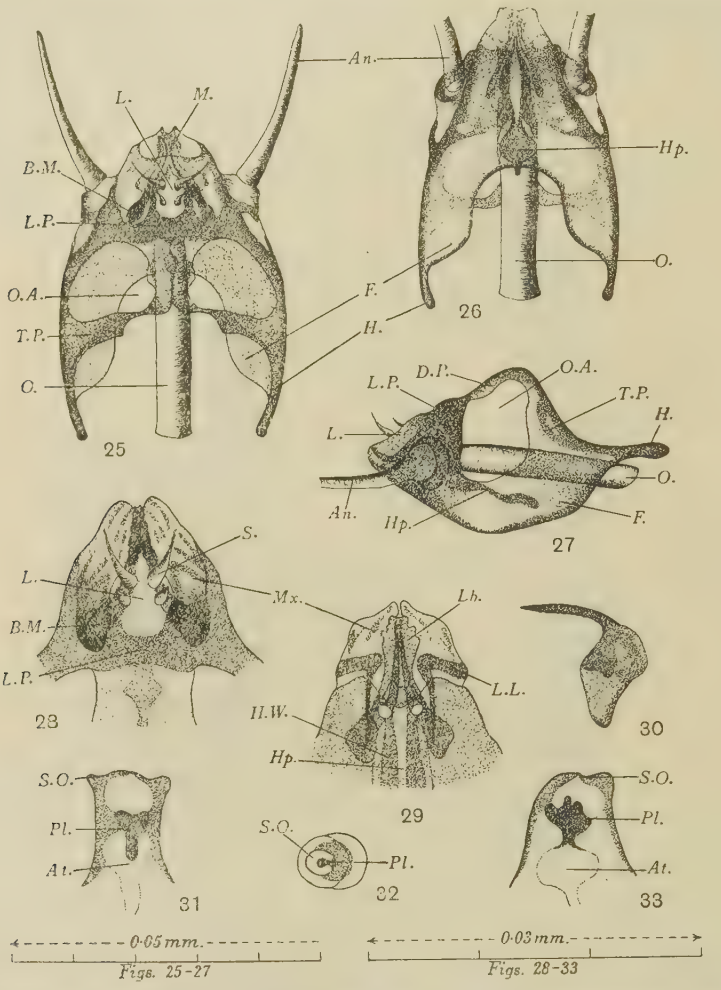


Figs. 23–24.—First instar larva of *L. miki*, first four and the last four segments :—
23. Dorsal surface; 24. Ventral surface.

The first instar larva measures from 0·45 mm. long, when just hatched, and grows to 0·65 mm. (fig. 22) before changing into the second instar. The number of segments (figs. 23 and 24), the positions of the fat body, anus (A.) and eyespot (E.) and the arrangement of the dermal structures are practically identical with those of the adult larva. The setae (D.S., L.S., and V.S.) are comparatively long, there are fewer rows of spines (Ss.) around the base of the pseudopods (P.), and on the ventral surface of the last abdominal segment there appear to be only two ventral swellings (Sw.) instead of three as in the adult larva.

The head capsule (figs. 25–30) measures approximately 0·045 mm. long by

0·03 mm. wide, and 0·025 mm. in greatest height, and in general structure appears very similar to that in the adult. In shape, however, it is more rounded, and the posteriorly directed lateral horns (H.) are not so long in proportion, the oesophagus (O.) extending almost to their ends. The degree of sclerotisation is, as would be expected, less, and on the anterior region of the ventral floor of

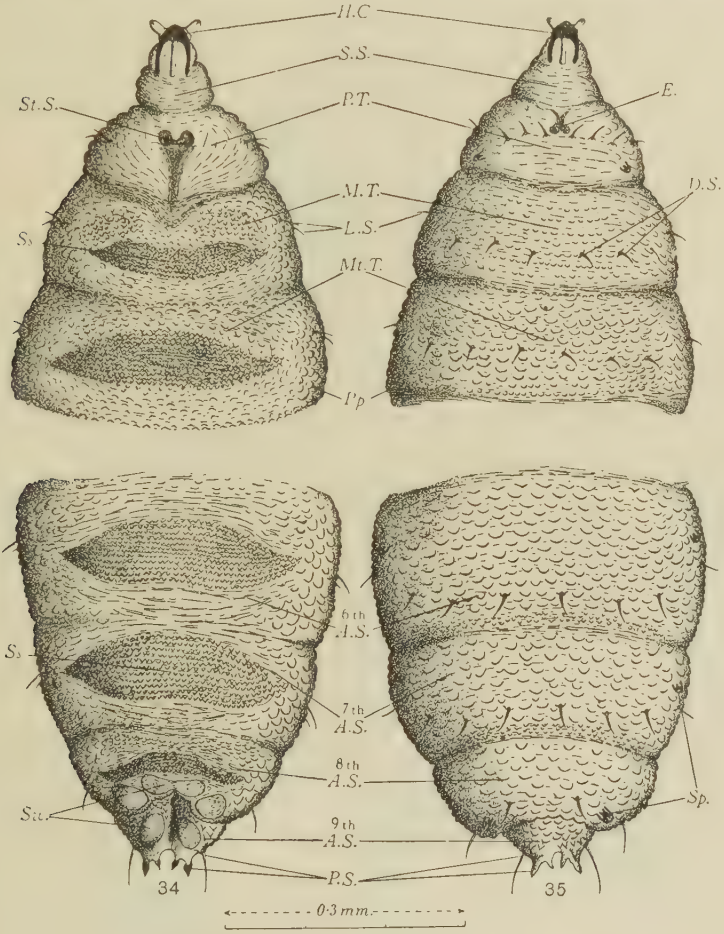


Figs. 25–33.—First instar larva of *L. miki*, head capsule :—25. Dorsal surface; 26. Ventral surface; 27. Lateral surface; 28. Anterior end, dorsal surface; 29. Anterior end, ventral surface; 30. Mandible. 31–33.—Spiracle :—31. Spiracle, lateral view; 32–33. Spiracle from above.

the head cone are some conspicuous oval, thinner areas. The labrum (L.) and hypopharynx (Hp.) appear almost identical with those of the adult larva, and mandibles (M.) very similar in shape (fig. 30) can be seen lying in their normal positions. On a closer inspection (figs. 28 and 29), especially of the ventral surface (fig. 29), the floor of the head with its two round lightly sclerotised areas or holes, and the two lateral structures (Mx.), together with their inverted

L-shaped pieces of chitin (L.L.), lateral rods and the presumed labrum (Lb.) with its papillae, can just be distinguished. The antennae (An.) are also identical in structure and shape, and the terminal segment measures approximately 0·028 mm. in length.

As in *L. alvei*, the first instar larva is metapneustic, with the only pair of spiracles (fig. 23, Sp.) situated on the eighth abdominal segment, in the same



FIGS. 34–35.—Adult larva of *C. cilicrus*, first four and last four segments :—34. Ventral surface; 35. Dorsal surface.

position as those in the adult larva. The spiracles (figs. 31–33) have only one spiracular opening (S.O.), which leads into a well-defined atrium (At.), in the middle of which is what appears to be a peculiar skeletal plug (Pl.) very similar to the cicatrix in the spiracles of the adult larva.

Clinodiplosis cilicrus Kieffer.

1. *General description of the adult larva* (figs. 2, 34 and 35).

The adult larva of *Clinodiplosis cilicrus* (fig. 2) is bright orange in colour and measures approximately 2 mm. in length and 0·6 mm. in greatest width, and the

body is composed of the usual thirteen segments excluding the head. The prothorax (figs. 34 and 35) bears on its ventral surface a bilobed sternal spatula (St. S.). The single eyespot (E.), which, as in *L. miki*, consists of two crescent-shaped pigmented regions, is situated in the normal position, as is the whitish fat body, whose lateral lobes are usually confluent. The dermal structures consist of setae (S.), papillae (Pp.) of various shapes and sizes, and spines (Ss.). There are no pseudopods, but friction pads (Sw.), as in *Lestodiplosis*, are present on the ventral surfaces of both the eighth and ninth abdominal segments. The supernumerary segment (Ss.) is devoid of setae and other dermal structures. The anus (A.) is slit-like and situated along the mid-ventral line on the last abdominal segment between two of the well-defined pads (Sw.), and is bordered by rows of spines on each side.

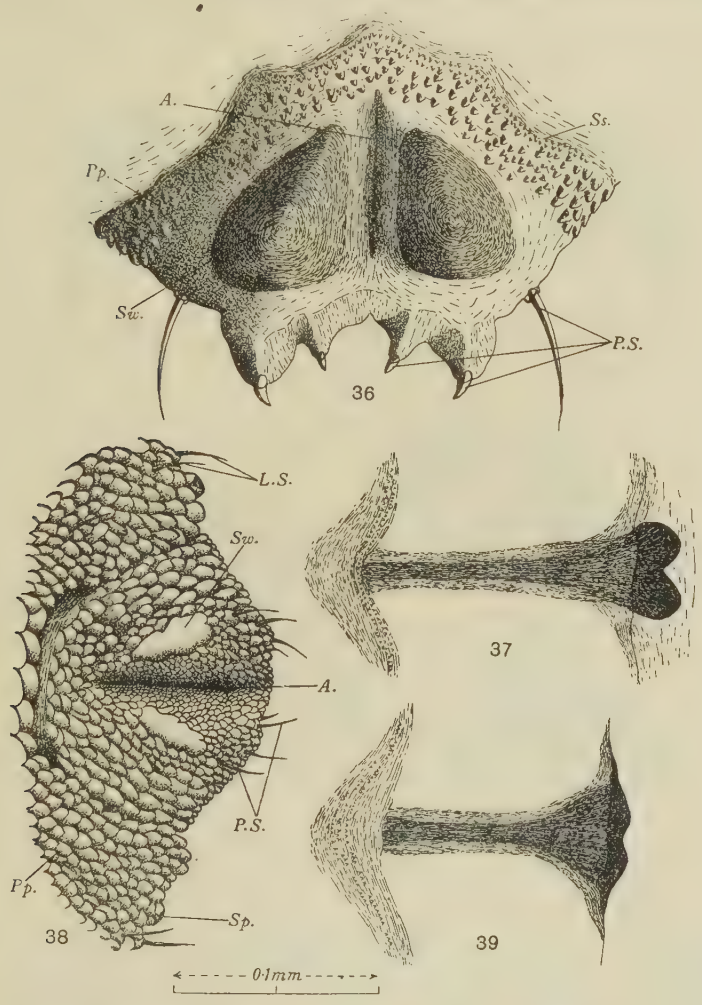
2. *The chaetotaxy and dermal structures* (figs. 34–37).

The chaetotaxy is essentially the same as in *Lestodiplosis*, but the setae are very short, averaging about 0·04 mm. in length, and there are no ventral setae whatever. Dorsally (fig. 35), except on the eighth and ninth abdominal segments (8th and 9th A.S.), the transverse row of six setae (D.S.), a median and two lateral pairs, are similarly placed, but the inner lateral pair appears to be of the same length as the others. On the prothorax (P.T.) the setae are all in a straight line, the middle pair not being set posteriorly to the others as in *Lestodiplosis*. On the eighth abdominal segment (8th A.S.) there is the usual pair of setae situated just inside the last pair of abdominal spiracles. Laterally there are the usual pair of setae (L.S.) on each side, which are typically placed just ventral to the spiracles (Sp.). The last abdominal segment (figs. 36 and 37) bears at its posterior extremity two pairs of very short and thick setae (P.S.), a median (0·01 mm. long) and a lateral (0·016 mm. long) pair. The median pair are situated on long outgrowths from the segment, the whole forming a four-pronged, fork-like tail. Immediately above, and slightly anterior to the lateral pair, is another similar pair of setae, but situated on not such long outgrowths, while laterally and immediately below is situated a typical pair of setae which are longer (0·05 mm.) than any on the rest of the body.

The sternal spatula (figs. 37 and 34, St.S.) is bilobed and emerges from a pocket in the skin which is situated roughly in the middle of the ventral surface of the prothorax (P.T.). Posteriorly it can be seen to taper under the skin as far as the posterior margin of this segment, where it joins the powerful muscles which cause its protrusion.

The dermal structures, as stated before, consist of papillae, setae and spines. The papillae (Pp.), which cover the dorsal and lateral surfaces of the adult larva, appear similar in type to the larva of *Dasyneura miki*, a description of which follows, but are not so large or numerous. On the dorsal surface (fig. 35) they are directed posteriorly, and run in irregular transverse rows across the segments, while laterally they appear to be arranged in no definite pattern. Ventrally (fig. 34) they are scarce, but when present are posteriorly directed and follow the same transverse arrangement as on the dorsal surface. In structure they seem to be protruding folds of the skin, the apices of which are sometimes round or pointed. The spines (Ss.) are very similar to those in *Lestodiplosis*. On the dorsal surface there are usually one or two transverse rows on the posterior border of the first seven abdominal segments, but on the thoracic and eighth and ninth abdominal segments they are absent. Ventrally there are large fusiform areas of spines, consisting of about a dozen transverse rows,

across the anterior of all the segments except the supernumerary (S.S.) and prothoracic (P.T.), but on the mesothoracic (Mt.T.) and eighth abdominal segments (8th A.S.) these areas are usually smaller, and only consist of about eight transverse rows. The spines in these fusiform areas are directed posteriorly, the whole area serving an ambulatory purpose, as do the pseudopods of *Lestodiplosis*. Elsewhere on the ventral surface spines occur on the anterior

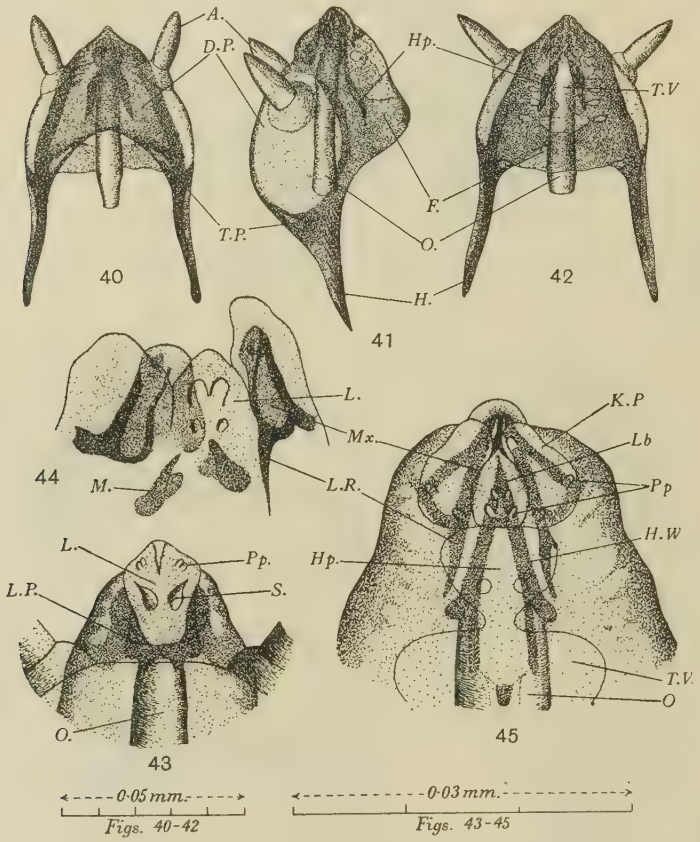


FIGS. 36–39.—Adult larva of *C. cilicrus* :—36. Last abdominal segment, ventral surface; 37. Sternal spatula. 38–39.—Adult larva of *D. miki* :—38. Last abdominal segment, ventral surface; 39. Sternal spatula.

and posterior edges of the segments and around the slit-like anus (fig. 36, A.). Raised pad-like swellings (Sw.) similar in structure to those on the last abdominal segment in *Lestodiplosis* occur on the ventral surfaces of the eighth and ninth abdominal segments (8th and 9th A.S.). On the eighth abdominal segment there are three, two lateral and a median bilobed pad, while on the ninth there are two lateral pads on either side of the anus.

3. *The head capsule* (figs. 40–45).

The head capsule of *Clinodiplosis cilicrus* is very much smaller than that of *Lestodiplosis*, and measures 0·08 mm. in length, 0·045 mm. in width and the same in height. As in *Lestodiplosis*, it consists of a sclerotised cone with its base prolonged posteriorly and laterally into two horns (H.), 0·038 mm. long. Dorsally the same triangular projections (T.P.) arise from each lateral horn (H.), which extend somewhat forward and meet in the mid-dorsal line 0·03 mm. from the apex of the head cone. There are no large lateral oval openings in this



FIGS. 40–45.—Adult larva of *C. cilicrus*, head capsule:—40. Dorsal surface; 41. Lateral surface; 42. Ventral surface; 43. Anterior end, dorsal surface; 44. Anterior end of a crushed specimen, ventral surface; 45. Anterior end, ventral surface.

head capsule, their place being taken by a uniform and comparatively thin area (D.P.) which forms the roof of the head and which bears anteriorly and laterally the two segmented antennae (An.). Between the antennae (An.) there is a distinct line of demarcation between this thin area and the thicker region which lies anterior to it and extends to the apex of the cone; little detail, such as the presence of a labrum-bearing-plate, etc., can however be seen except under a very high magnification. Ventrally the floor of the head capsule consists of an area with many local thickenings and thin places, the most conspicuous being an irregular thin area (T.V.) which extends forwards to the apex from about the

middle of the head capsule. Anteriorly can be seen the obscure outlines of an underlying hypopharynx-like structure (Hp.). Laterally the thin area (D.P.) composing the dorsal surface, and the thicker ventral surface can be seen to join in the form of an arc. The oesophagus (O.) is short and narrow, and extends backwards 0·05 mm. from the apex of the head. The antennae (An.) are short and pointed, and are composed of two segments, a short basal one 0·005 mm. long, and a longer terminal one 0·017 mm. long.

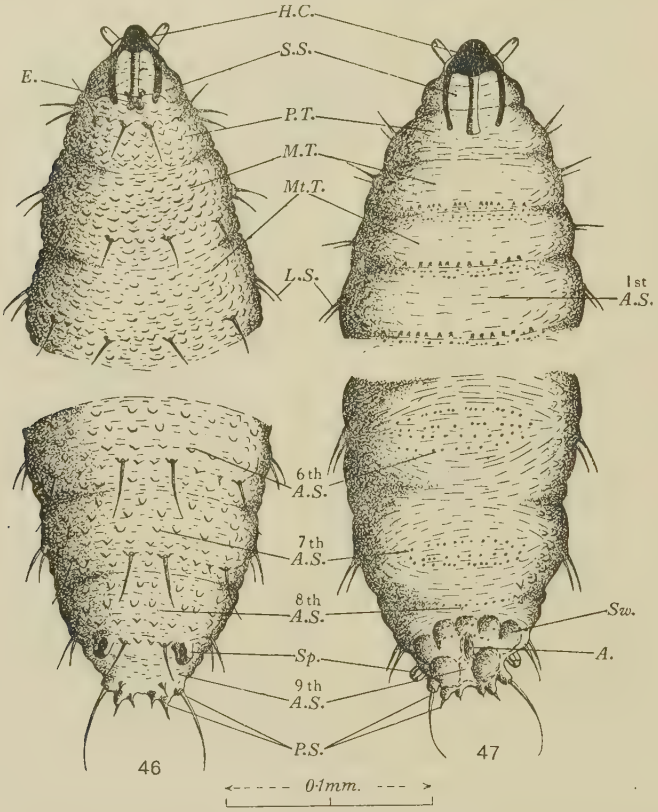
A high magnification shows up the following detail in the anterior end of the head capsule. Dorsally (fig. 43) can be seen a thickly sclerotised U-shaped labrum-bearing-plate (L.P.) which bears anteriorly a labrum (L.) similar to that in *Lestodiplosis*, but in the present species the anterior pair of setae are absent and their place is taken by a pair of minute papillae (Pp.) on each side. At its apex is a triangular mark. What lies immediately underneath the labrum-bearing-plate (L.P.) and labrum (L.) it is impossible to define, but from a crushed head capsule (fig. 44) two small blunt bilobed sclerites (M.) were separated out which appeared to have come from this region, and which may represent the hook-like mandibular structures found in *Lestodiplosis*. On account of the minute size, and the masking of detail by the antennae, it was impossible to make out any detail in lateral view. Ventrally (fig. 45) the anterior boundary of the head capsule could not be seen, but the thin irregular-shaped area ended as in *Lestodiplosis*, just anterior to two lateral clear areas or holes. Anterior to this and joining it at its base, is a small median triangular plate (Lb.) as in *L. miki*, which bears two pairs of laterally placed papillae (Pp.). This possibly corresponds to the labrum. On either side of this median plate, and also joining the thin area at their bases, are two thin kidney-shaped plates (K.P.) which each bear three papillae (Pp.), one anterior, one lateral and one posterior. Underneath lies the small hypopharynx (Hp.). This terminates anteriorly in an arrow-shaped structure with thickly sclerotised sides, but it is difficult to determine if this pointed structure is actually part of the hypopharynx or the anterior end of the underlying oesophagus with the mouth at its apex. Posteriorly two short lateral rods (H.W.) extend backwards as in *Lestodiplosis*, and presumably they form the thickened lateral walls of the hypopharynx tube. There is no bulb-like swelling or reservoir, but the thick posterior end (H.E.) is present, but inconspicuous, between the posterior terminations of the thick lateral walls (H.W.). Lying lateral to the ends of the hypopharynx (Hp.), and beneath the lateral kidney-shaped plates (K.P.) mentioned above, are two triangular-shaped sclerites (Mx.) which correspond in position to the similar structures found in *Lestodiplosis*. These structures, possibly maxillary appendages, are thickened around their three sides and have a short backwardly projecting rod (L.R.) which lies about parallel to the thickened walls of the hypopharynx (H.W.); the rod possibly corresponds to the lateral rods (L.R.) or the lateral L-shaped sclerites (L.L.) in the similar structures in *L. miki*. From a crushed specimen (fig. 44) the anterior ends of these structures (Mx.) appear to be flattened dorso-ventrally.

4. *The respiratory system* (figs. 19, 53 and 54).

As in *L. miki*, the respiratory system is peripneustic and the number and position of the spiracles and their size and structure differ little from that species. The prothoracic and the first seven abdominal spiracles (fig. 54) have likewise two spiracular openings (S.O.) and the eighth abdominal (fig. 53) four. The cicatrix (C.) is perhaps a little more oval in shape when seen in surface view

than in *L. miki*. There is a well-defined flask-shaped atrium (At.) and no filtering apparatus.

The system of tracheal trunks in *C. cilicrus* (fig. 19) is much the same as in *Lestodiplosis miki*, except for certain small differences in the relative length of some of the minor branches, and the following differences. The dorsal system (D.T.) is identical, except that on the transverse branches (D.T.T.) on either side of the ampulla (Am.) there arises a small anteriorly directed branch (D.B.) which ramifies after a short distance. The main ventral trunks (V.T.) follow the same course, but in the thorax they are even more convoluted; there are,



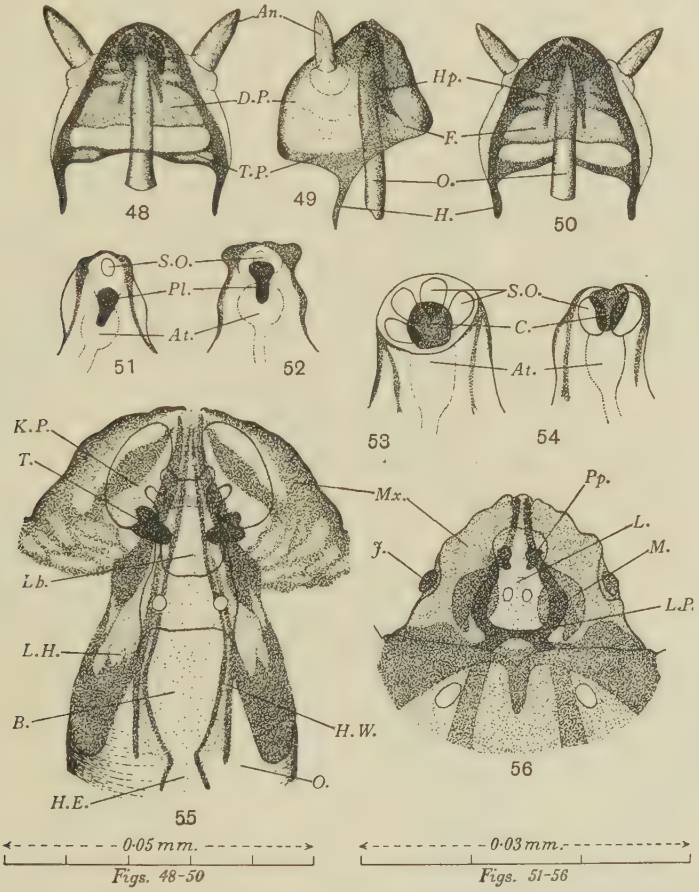
FIGS. 46–47.—First instar larva of *C. cilicrus*:—46. Dorsal surface, first four and the last four segments; 47. Ventral surface, first five and the last four segments.

however, differences in the number of smaller branches. In all the abdominal segments there are two branches from each loop of the main ventral trunks (V.T.), a large anteriorly running branch (V.B.) corresponding to the single one (V.B.) in *L. miki*, and posteriorly a small ventrally ramifying branch (V.V.), which in *L. miki* appears to be part of the above (V.B.). In the thorax there appears to be no ampullae on the short tubes which join the posteriorly directed ventral branches (V.A.).

5. *The first instar larva* (figs. 21, 46–52).

The first instar larva of *Clinodiplosis cilicrus* (fig. 21) measures approximately 0·425 mm. long when newly hatched, and the number and shape of the segments

(figs. 46 and 47) and the position of the eyespot (E.), anus (A.) and fat body are the same as in the adult larva. The chaetotaxy is also the same as in the adult larva, but on the thorax the middle pair of dorsal setae appears to be absent, and on the abdominal segments are only very small. The other setae are in proportion longer than in the adult, although they only average 0·025 mm. long for those on the body, while the two long postero-lateral ones (P.S.) on the



FIGS. 48–56.—First instar larva of *C. cilicrus*, head capsule:—48. Dorsal surface; 49. Lateral surface; 50. Ventral surface. 51–54.—Spiracles of the larvae of *C. cilicrus*:—51–52. Spiracle of first instar larva; 53. Last abdominal spiracle of the adult larva; 54. Prothoracic or abdominal spiracle of the adult larva. 55–56.—Adult larva of *D. miki*, head capsule:—55. Anterior end, ventral view; 56. Anterior end, dorsal view.

last abdominal segment are 0·04 mm. long. The papillae (Pp.), which are so conspicuous on the dorsal and lateral surfaces of the adult larva, are in this instar small and widely spaced, and appear to be practically absent on the ventral surface. Spines (Ss.) only occur on the ventral surface and are very minute, resembling studs. On the thoracic and first two abdominal segments the fusiform areas are very small, and composed of only about two or three transverse rows of spines, while on the other abdominal segments the number of

rows is rarely more than six. The friction pads (Sw.) on the last abdominal segment have a similar position to those in the adult larva, but on the eighth there is a median and two lateral pads. There is no sternal spatula.

The head capsule (figs. 48–50) is very minute, measuring approximately 0·03 mm. in length and width and 0·025 mm. high. In shape it is not nearly so drawn out posteriorly as in the adult larva. The lateral horns (H.) are very short (0·01 mm. long), but the dorsal triangular projections (T.P.), the thin lightly sclerotised roof (D.P.) and the thicker floor all follow the same plan. On account of its small size and feeble sclerotisation, very little detail could be made out in the labrum and mouth-parts. The outline of a hypopharynx (Hp.) could be seen through the ventral surface, which appears to possess no distinct thinner areas, as in the adult larva. The oesophagus (O.) is comparatively long (0·25 mm.), and the antennae (An.) are also composed of two segments, a very short basal one 0·003 mm. long and a longer terminal one of 0·01 mm.

As in *Lestodiplosis*, the first instar larva is metapneustic, with the only pair of spiracles (fig. 46, Sp.) situated on the eighth abdominal segment in the same position as on the corresponding segment in the adult larva. The spiracles (figs. 51 and 52) are very similar to those in the first instar larva of *L. alvei*. They have only one spiracular opening (S.O.) and a well-defined atrium (At.), in the middle of which is the peculiar sclerotised plug (Pl.) mentioned before.

Dasyneura miki Kieffer.

1. *General description of the adult larva* (figs. 3, 38, 39, 57 and 58).

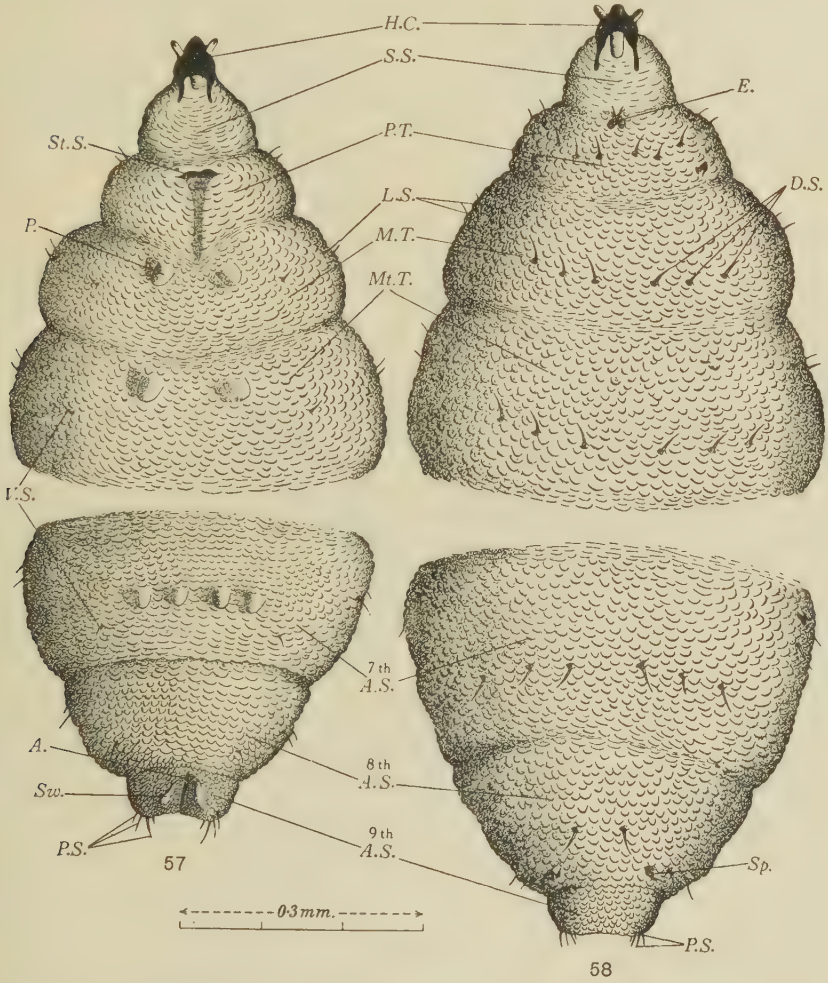
The adult larva of *Dasyneura miki* (fig. 3) is pinkish-white in colour and measures approximately 2·3 mm. long and 0·65 mm. in greatest width, and is composed of the usual thirteen segments excluding the head. The structure and position of the eyespot (fig. 58, E.) are the same as in the larvae of *Lestodiplosis miki* and *Clinodiplosis cilicrus*, and also as described and figured for *Dasyneura leguminicola* by Metcalf (1933, pl. I, fig. 108 and pl. VI, fig. 35). The fat body is also of the same shape as described for the last-named species. The prothorax (figs. 57 and 58, P.T.) bears on its ventral surface a bilobed sternal spatula (St.S.) which is characteristic of this genus, and somewhat similar to that of *Clinodiplosis*. The dermal structures consist of setae, papillae (Pp.) and spines of various shapes and sizes. The supernumerary segment (S.S.), as in the other species described, is devoid of setae and papillae, but the skin appears somewhat wrinkled. The rest of the body is covered with conspicuous papillae (Pp.), but spines are scarce and inconspicuous. On the ventral surfaces of all the segments, except the supernumerary, prothorax and eighth and ninth abdominal segments, some of these papillae are greatly enlarged (P.). The anus (figs. 38 and 57 A.) is slit-like, and, as in *D. leguminicola* and *C. cilicrus*, is situated along the mid-ventral line on the last abdominal segment between two irregular-shaped friction pads (Sw.).

2. *The chaetotaxy and dermal structures* (figs. 38, 39, 57 and 58).

The external morphology of *Dasyneura leguminicola* is not described by Metcalf (1933), but the description of *D. miki* (figs. 38, 57 and 58) which follows is probably in the main applicable to the former species also.

The chaetotaxy (figs. 57 and 58) is similar and the setae are approximately of the same length as in *C. cilicrus*, but typical ventral setae (V.S.), situated as in *Lestodiplosis miki*, occur on all the segments except the supernumerary (S.S.),

prothoracic (P.T.) and ninth abdominal (9th A.S.). The ventral setae (V.S.) are small and average only 0·02 mm. in length, and on the meso- and metathorax they are not accompanied by the two minute inner pairs that are found in *L. miki* and *L. alvei*. The ninth abdominal segment (fig. 38) bears posteriorly four pairs of short laterally placed setae (P.S.) situated in two vertical rows, a dorsal pair, an upper and a lower posterior pair, and a ventral pair. The



FIGS. 57–58.—Adult larva of *D. miki*, first four and the last three segments :—
57. Ventral surface; 58. Dorsal surface.

papillae (Pp.) are larger and more numerous than in *Clinodiplosis cilicrus*, but otherwise follow much the same pattern. Ventrally, they are far more numerous. All the papillae have rounded apices, and except laterally are mostly directed posteriorly. The enlarged papillae, which, as mentioned before, occur on the ventral surfaces of all the segments, except the supernumerary, prothorax and eighth and ninth abdominal, are approximately three times the normal size, and form what might be called very short and blunt

pseudopods (P.). On the meso- and meta-thoracic segments (M.T. and Mt.T.) these enlarged papillae (Pp.) are 0·03 mm. long, while on the abdominal segments they are slightly shorter. They occur in transverse rows across the middle of those segments that bear them, the thoracic segments having two each and the abdominal segments a row of four. The eighth abdominal segment (8th A.S.) is entirely devoid of these enlarged papillae, while the ninth (9th A.S., fig. 38) has a pair of irregular-shaped pads (Sw.), which are situated on either side of the anus.

The sternal spatula (fig. 39) emerges from a pocket in the skin on the ventral surface of the prothorax. It is bilobed, but not nearly so pronouncedly so as in *C. cilicrus*, or even in that of *D. leguminicola* (Metcalf 1933, pl. I, fig. 3), and its margins are drawn out laterally. It can be seen to extend backwards under the skin as far as the posterior margin of the prothorax, as in *C. cilicrus*.

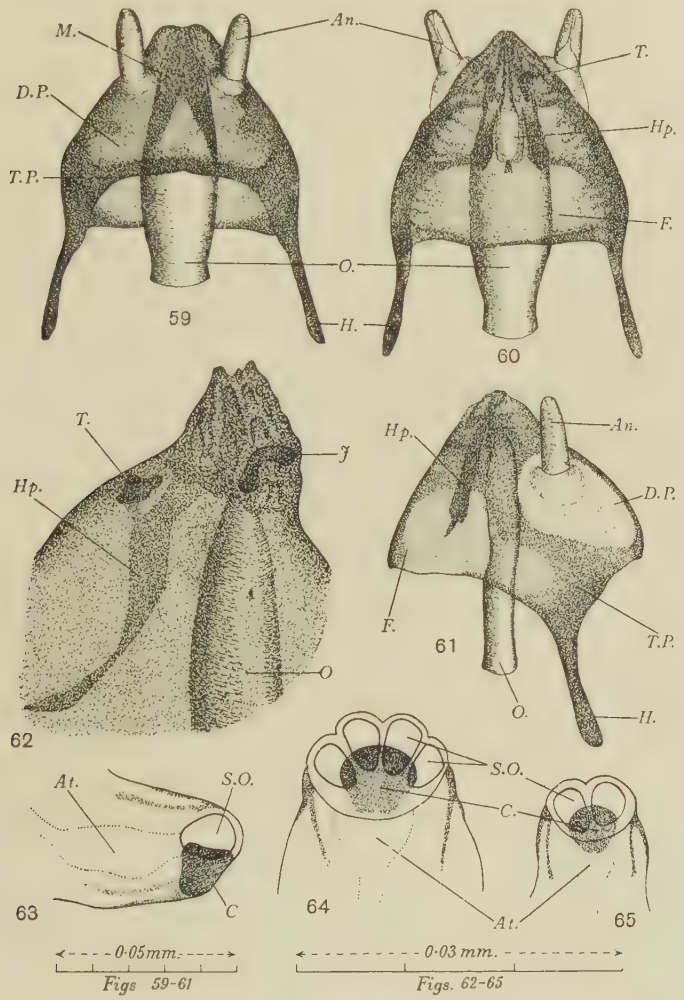
3. *The head capsule* (figs. 55, 56 and 59–62).

The head capsule (figs. 59–61) of *Dasyneura miki* is considerably larger, but except for slight variations in shape, is very similar to that of *C. cilicrus*. It measures 0·1 mm. long, 0·065 mm. wide and 0·07 mm. high, and the horns (H.) project backwards for about 0·035 mm. The dorsal triangular projections (T.P.) arise almost vertically, and the roof of the head capsule is likewise composed of a thin area (D.P.) which bears the antennae (An.) anteriorly. Ventrally the floor of the head is composed of a thicker area than the roof, and has thick pointed areas extending into it from the sides, while the outlines of a hypopharynx (Hp.) and other mouth-parts can be seen underneath. The oesophagus (O.) is long and very wide (0·02 mm.), and is somewhat flattened dorso-ventrally; it extends backwards about 0·08 mm. from the apex of the head. The antennae (An.) are short and blunt, and are composed of two segments, a short basal one 0·005 mm. long and a longer terminal one of 0·02 mm.

Under a high magnification the following detail can vaguely be discerned in the anterior region of the head capsule. Dorsally (fig. 56) can be seen a horse-shoe-shaped thickened area, which corresponds in position to what was termed the " labrum-bearing-plate " (L.P.) in *L. miki* and *C. cilicrus*. The arms of this plate point anteriorly, while posteriorly and laterally two thick projections extend, which run into the dorsal region of the head capsule. In the centre of the U-shaped " labrum-bearing-plate " (L.P.) is a thinner plate, presumably the labrum (L.). This bears posteriorly a pair of transparent areas which may be sense-pits, and anteriorly a pair of irregularly-shaped papillae (Pp.). Underneath the " labrum-bearing-plate " (L.P.) and the labrum (L.) can be faintly seen two rods with thickened bases (M.) which correspond in position and look somewhat like the hook-like mandibular structures seen in *Lestodiplosis*. Although many head capsules were crushed, these objects could not be separated without being broken, so their exact structure was not discovered. Laterally (fig. 62) are two large areas of irregular shape (Mx.) and varying in thickness, corresponding to those found in *L. miki* and *C. cilicrus*, and which, as stated before, may be maxillary appendages. In this species these lateral structures bear on their outside and in the middle of their lateral margins a conspicuous J-shaped projection (J.) whose apex points dorsally. This structure (J.) is short and blunt and the same thickness for its whole length.

On the ventral surface (fig. 55) of the apex of the head a series of four thin plates can be distinguished as in *C. cilicrus*. A basal plate, with two lateral transparent areas circular in shape, which may be sense-pits; a median plate

(Lb.), roughly triangular, which has two pairs of short blunt-ended outgrowths, a lateral and an anterior pair; and laterally, two elliptical plates (K.P.) devoid of all outgrowths, which join the median plate, the whole structure undoubtedly corresponding to the so-called labrum with its lateral kidney-shaped plates as found in *C. cilicrus*. Immediately underneath the presumed labrum, at about



FIGS. 59–65.—Adult larva of *D. miki*, head capsule:—59. Dorsal surface; 60. Ventral surface; 61. Lateral surface; 62. Anterior end, lateral surface. 63–65.—Spiracles:—63–64. Prothoracic or abdominal spiracle; 65. Eighth abdominal spiracle.

the junction of the lateral and median plates, can be seen a small but conspicuous triangular sclerite (T.), and below this again the hypopharynx (Hp.). The dorsally situated rod-like structures (M.) can just be seen through the overlying tissues. The hypopharynx (Hp.) appears to possess two large lateral pouches (L.H.) and a central chamber (B.), which probably corresponds to a reservoir, and is pointed posteriorly. The posterior knob-like sclerite (H.E.), so con-

spicuous in *L. miki* and *C. cilicrus*, appears under a high magnification in the present species to be the thickened walls of the end of a tube, which enters the central chamber at its anterior end. The central chamber or reservoir (B.) and the anterior end of the hypopharynx have thickened walls (H.W.) corresponding to those in *C. cilicrus* and *L. miki*. Laterally (fig. 62) little detail can be seen through the thickness of the large lateral objects or maxillae (Mx.), but their J-shaped lateral outgrowths (J.) are plainly visible. Other conspicuous features are the small but thick triangular ventral pieces (T.) and the dorso-ventrally flattened oesophagus (O.), which has apparently a particularly thick ventral wall. The posterior end of the hypopharynx bends down ventrally, as in *L. miki* and *C. cilicrus*.

4. *The respiratory system* (figs. 63–65).

The respiratory system of the adult larva is peripneustic as in *L. miki* and *C. cilicrus*. The spiracles (figs. 63–65) are a little larger than in the last two species, but otherwise similar in general structure. The prothoracic and first seven abdominal spiracles (figs. 63 and 64) measure about 0·008 mm. in diameter, and their spiracular openings 0·005 mm. in greatest width. As in the last two species, the prothoracic and first seven abdominal spiracles have two spiracular openings (S.O.) and the eighth four. The spiracles on the eighth abdominal segment (fig. 65) are about 0·01 mm. in diameter, and all project about 0·018 mm. above the surrounding surface of the segments. The cicatrix (C.) is even more circular in surface view than in *C. cilicrus*. There is a well-defined flask-shaped atrium (At.) and no apparent filtering mechanism. Metcalf (1933, pl. V, fig. 29) described and figured the spiracles of *D. leguminicola* as consisting of a single opening which leads into a flask-shaped atrium, but drew no distinction between the eighth abdominal pair and the others. She stated that the atrium is traversed by a delicate network of protoplasmic threads or trabeculae, but no such structures were apparent in the spiracles of *D. miki*.

Metcalf (1933) has described the tracheal system in *Dasyneura leguminicola*, and as much difference in this respect between this species and *D. miki* is improbable, a comparison is here drawn between her description of that of *D. leguminicola* (p. 124–125 and pl. IV, figs. 27 and 28, and V, figs. 30 and 31) and that of *Lestodiplosis miki* and *Clinodiplosis cilicrus*. Fundamentally the tracheal system is very similar to that of *C. cilicrus*. The dorsal system apparently differs, however, by the addition of a branch joining the dorsal and ventral systems in the mesothorax; a transverse-joining branch in the seventh abdominal segment, which arises from the lateral trunks posterior to the lateral-joining branch in that segment; and three small dorsal branches from the main dorsal trunks in the meso- and meta-thorax. The ventral system appears almost identical with that of *C. cilicrus* except in detail.

Summary and Discussion.

1. The external morphology and anatomy of the head capsules of the adult larvae of *Lestodiplosis miki*, *Clinodiplosis cilicrus* and *Dasyneura miki*, and that of the first instar larvae of *L. miki* and *C. cilicrus* are described, together with the respiratory system of the adult larvae of *L. miki* and *C. cilicrus*.

2. The three species described play a comparatively small part in the economy of the insect population in the flower-heads of *Centaurea nigra* (*see* G. C. Varley's paper, shortly to be published). Mik (1896), however,

described and figured a gall on *Centaurea scabiosa* formed by the larva of a species of *Dasyneura*. This larva is described by Kieffer in the same paper as closely resembling that of *D. lowii* Mik, and the sternal spatula is figured. Neither Varley nor myself have found any Cecidomyid galls in the flower-heads of *Centaurea nigra*, and as the sternal spatula differs considerably from that of *D. miki*, it is safe to presume that Mik's larva is that of a different species of *Dasyneura* which does not occur in *Centaurea nigra*.

3. The adult larvae of *L. miki* and *L. alvei* (Otter 1934) appear very similar. According to Barnes, many of the imagines of this genus show few or no structural specific differences, and possibly many of the larvae would be equally difficult to distinguish.

4. The dermal structures of Cecidomyid larvae have been classified by Rubsaamen (1891) and Kieffer (1895 and 1900). Their descriptions are rather discrepant, and are difficult to follow. The pairs of spines on the ventral surfaces of the segments in the larvae of *C. cilicrus*, however, can be identified as Kieffer's " Verrucae spiniformes larvinosae," and those on the lateral and dorsal surfaces of the larvae of *C. cilicrus* and *L. miki* as " Verrucae spiniformes," while the papillae which cover the surface of the body of the larvae of *C. cilicrus* and *D. miki* correspond to his " Verrucae cingentes."

Kieffer (1900) figures pseudopods as enlarged papillae as in *D. miki*, or as the elongated more specialised type found in *Lestodiplosis*.

5. Kieffer (1895 and 1900) somewhat confuses the chaetotaxy by the fact that he includes the setae in his classification of dermal structures under the heading of " Setae-bearing papillae." On comparing the arrangement of the setae in the larvae of these three species with the figures and descriptions of other Cecidomyid larvae, the chaetotaxy appears comparatively constant throughout the group. The typical number being three pairs of dorsal setae, the " papillae dorsales " of Kieffer (1900), two pairs of lateral setae " papillae laterales," and a pair of ventral setae on all the segments except the supernumerary and eighth and ninth abdominal.

6. In my paper on the life history of *L. alvei* (Otter 1934) an attempt was made to compare the morphology of the head capsule of the adult larva of the species with those of other Cecidomyid larvae whose head capsules had been figured or described, however briefly, by other authors (Marchal 1897, Kieffer 1900, Williams 1910, Hasemann 1930 and Metcalf 1933). According to Kieffer's classification (1895, 1896 and 1900), the genus *Dasyneura* belongs to the *Lasioptera* group, while *Clinodiplosis* and *Lestodiplosis* belong to the *Diplosis* group, two widely separated groups of the CECIDOMYIDAE, yet the head capsules of all these three species, which are here described in detail, show many similarities, such as the conical shape, the presence of backwardly projecting horns and antennae, as well as a series of mouth-parts. The larval mouth-parts probably vary greatly throughout the CECIDOMYIDAE, as they do in other Dipterous larvae, but in the larvae of the three species described there is dorsally a well-defined labrum, and underneath a pair of laterally placed mandibles (well developed in *Lestodiplosis* but greatly reduced in both *Clinodiplosis* and *Dasyneura*), between which lies the mouth opening. Immediately underneath lies the hypopharynx, which is well developed in all three species. On either side of the hypopharynx are large objects whose outlines are very obscure and which appear to form the sides of the anterior end of the head capsules. These structures, if appendages at all, may represent the maxillae or their rudiments. On the ventral surface lies a sclerite or series of plates which may represent the labium. The presumed labium in *C. cilicrus* and *D. miki* consists of a median

plate, which may be the mentum or submentum, and two lateral kidney-shaped plates which may be palps. In *L. miki*, however, the lateral kidney-shaped plates are absent.

7. The tracheal systems of the adult larvae of *L. miki* and *C. cilicrus*, when compared with those of other Cecidomyid larvae (Kieffer 1900 and Marchal 1897), appear very similar, and it is probable that throughout the group the system is much the same as in *Lestodiplosis*. A detailed comparison is made between the tracheal systems of *L. miki* and *C. cilicrus* and that of *D. leguminicola* described by Metcalf (1933).

8. The spiracles of the Cecidomyid larvae that have hitherto been described are mostly figured somewhat crudely and are therefore useless for comparison. De Meijere (1895) does not describe or figure a spiracle of a Cecidomyid larva in his well-known paper on the spiracles of Dipterous larvae, but his description and figure of those in the larva of *Mycetophila punctata* (Mycetophilidae) closely resemble the larger spiracles on the eighth abdominal segment in the adult larvae of these three species.

9. The absence of a sternal spatula (in those species that possess one) and the metapneustic respiratory system in the first instar Cecidomyid larva is mentioned by Marchal (1897) and Kieffer (1896 and 1900). The peculiar structure of the spiracles found in the first instar larva of *L. miki* and *C. cilicrus*, however, do not appear to have been noticed so far.

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LETTERING COMMON TO ALL THE FIGURES.

A. Anus.
Am. Ampulla (tracheal system).
An. Antennae.
A.S. Abdominal segment.
At. Atrium (spiracles).
B. Reservoir of hypopharynx.
Bm. Base of mandibles in *Lestodiplosis miki.*
C. Cicatrix or stigmatic scar (spiracles).
D.A. Posterior dorsal trachea from prothoracic spiracle.
D.B. Anterior branches from the dorsal transverse tracheae in *Clinodiplosis cilicrus.*
D.H. Trachea running to head capsule from prothoracic spiracle.
D.P. The thin dorsal area of the head capsule.
D.S. Dorsal setae.
D.T. Dorsal tracheal trunk.
D.T.T. Dorsal transverse tracheae.
D.V. The ventrally running branch from the end of the dorsal tracheal trunk in the eighth abdominal segment.
E. Eyespot.
F. Ventral fins of the head capsule.
H. Posterior directed horns of the head capsule.
H.C. Head capsule.
H.E. The thickened end of the hypopharynx.
Hp. Hypopharynx.
H.W. The thickened lateral walls of the hypopharynx.
J. The J-shaped projections from the presumed maxillae in *Dasyneura miki.*
K.P. The kidney-shaped plates on either side of the presumed labrum in *C. cilicrus* and *D. miki.*
L. Labrum.
Lb. Labium.
L.H. The lateral pouches of the Hypopharynx in *D. miki.*
L.L. The lateral L-shaped sclerites in the maxillae of *L. miki.*
L.P. The labrum-bearing-plate.
L.R. The lateral rods of the presumed maxillae.
L.S. Lateral setae.
L.T. Lateral transverse tracheae.
M. Mandibles.
Mo. The mouth in *L. miki.*
M.T. Mesothorax.
Mt.T. Metathorax.
Mx. The presumed maxillae.
O. Oesophagus.
O.A. The oval aperture in the head capsule of *L. miki.*
P. Pseudopods.
Pl. The peculiar sclerotised plug found in the atria of the spiracles in the first instar larvae of *L. miki* and *C. cilicrus.*
P.M. The points of the mandibles in *L. miki.*
Pp. Papillae.
P.S. Posterior Setae.
P.T. Prothorax.
S. Setae.

S.O. Spiracular openings.
Sp. Spiracles.
S.S. Supernumerary segment.
Ss. Spines.
St.S. Sternal spatula.
Sw. Ventral pad-like swellings on the eighth (*C. cilicrus*) and ninth abdominal segments.
T. The triangular sclerite under the labium in *D. miki*.
T.P. The dorsal triangular outgrowths of the head capsule.
T.V. The thin ventral area of the head capsule.
V.A. Posterior directed trachea from the ventral tracheal trunks in the pro-, meso-, and meta-thorax.
V.B. Anterior directed branch from the ventral tracheal trunks in the abdominal segments.
V.P. Posterior directed ventral trachea from the spiracle on the seventh abdominal segment.
V.S. Ventral setae.
V.T. Ventral tracheal trunk.
V.V. The ventrally ramifying trachea from the ventral tracheal trunks in *C. cilicrus*.